Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study

Findings from Second Peer Review Panel Meeting

final

report

prepared for

Metropolitan Transportation Commission

prepared by

Cambridge Systematics, Inc.

with

Mark Bradley Research & Consulting
SYSTRA Consulting, Inc.

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draft report

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1.0 Introduction

1.1 Objectives

The primary objectives of the Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study (HSR Study) are to provide information for the development of the Bay Area Regional Rail Plan, and to provide information to update environmental analyses to be conducted by the California High-Speed Rail Authority (CHSRA). More specifically, the HSR Study will develop a new statewide travel demand model system designed expressly for the purpose of evaluating a proposed high-speed rail (HSR) system connecting major metropolitan areas between Southern and Northern California. The new model system will also be used to evaluate different HSR alignment options between the Central Valley and the Bay Area.

The Metropolitan Transportation Commission (MTC), together with the CHSRA, selected a consultant team led by Cambridge Systematics (CS) to create the travel demand model system, and to evaluate a series of alternative high-speed rail alignment scenarios. Part of the contract included holding a series of three peer review panel meetings to evaluate all major aspects of model development and application. The peer review panel enhances the credibility of the process by providing an objective and independent review of the models, assumptions, methodologies, and results.

1.2 Peer Review Panel

The purpose of the second peer review panel meeting was to provide technical guidance in the model specification and estimation, and on the forecasting assumptions. The first peer review panel meeting, held in June 2005, reviewed the proposed model design, survey data collection plan, and proposed performance measures. The third and final meeting will review the model calibration and initial forecast models with several high-speed rail alternatives.

CS worked with MTC and CHSRA to identify peer review panel members that included several members from the private sector, interested public agencies, and academics. The list of peer review members who attended the 2nd peer review panel meeting is:

- Ayalew Adamu (California Department of Transportation (Caltrans) Headquarters);
- Jean-Pierre Arduin (independent consultant);
- Chris Brittle (independent consultant representing MTC);
- Billy Charlton (San Francisco County Transportation Authority (SFCTA));

- Kostas Goulias (University of California at Santa Barbara);
- Keith Killough (Southern California Association of Governments (SCAG));
- Frank Koppelman (Northwestern University);
- Chausie Chu (Los Angeles County Metropolitan Transportation Authority (Metro)); and
- Kazem Oryani (URS Corporation).

In addition, a number of observers were invited to the peer review panel meetings, including the following:

- Malcolm Quint (Bay Area Rapid Transit District (BART));
- Carl Schiermeyer (Riverside County Transportation Commission);
- Tom Matoff (LTK Engineering); and
- Joe Castiglione (Parsons Brinckherhoff).

In addition to the peer review members, there were representatives from MTC (Chuck Purvis) and CHSRA (Dan Leavitt) who are managing the overall study and consultant team members present at the meeting: Maren Outwater (Project Manager), Ron West, Vamsee Modugula, Arun Kuppam, Elizabeth Sall, Chris Wornum, George Mazur, Mark Bradley, and Nick Brand. CS hosted the second peer review panel meeting on June 2, 2006 in Oakland, California. The third and final meeting is scheduled to be held in late summer 2006.

1.3 Contents of This Report

The body of this report is organized into three additional sections based on the agenda of the first peer review meeting and an overall summary of the recommendations and next steps. These sections are:

- Section 2.0 – Review of Model Design;
- Section 3.0 – Interregional Travel Models;
- Section 4.0 – Forecast Assumptions; and
- Section 5.0 - Summary.

Each section begins with a summary of the scope of work and the CS team's proposed approach. Peer review panel comments are summarized, along with responses. Finally, an action plan is provided to outline how the proposed work plan has been changed from the input of the peer review panel members, as well as descriptions of upcoming activities.

There are two reports that were delivered to the peer review panel for review and contain the technical information and background material that is referenced in this report:

- *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study Interregional Model System Development*, Cambridge Systematics, May 2006.
- *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study Level-of-Service Assumptions and Forecast Alternatives*, Cambridge Systematics, May 2006.

In addition, there are a set of presentation slides that summarized the documentation efforts that are available.

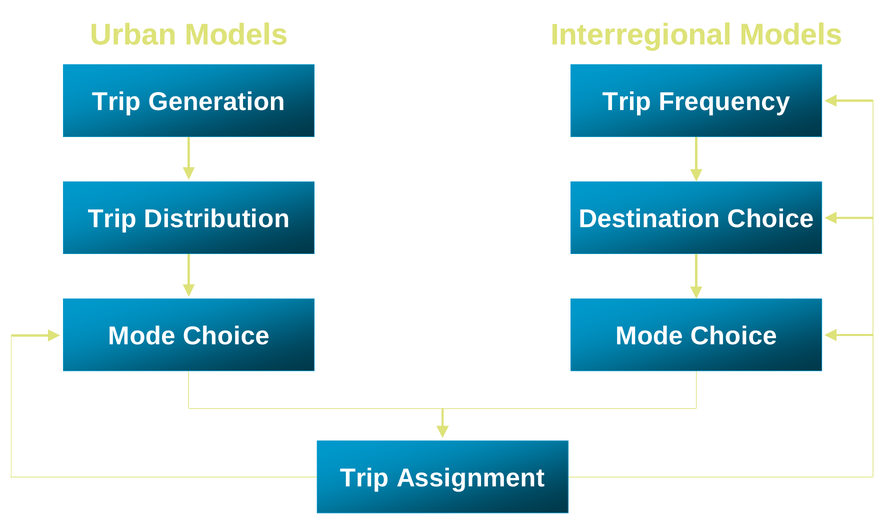
2.0 Review of Model Design

2.1 Summary of Approach

The project objectives were revisited to demonstrate the initial and potential uses of the new ridership model for a variety of planning and operational purposes. Initially, the focus of the model is to evaluate high-speed rail on a statewide basis and to evaluate potential alternative alignments for high-speed rail into and out of the San Francisco Bay Area. There is ongoing coordination between this study and the MTC Regional Rail Study and the CHSRA environmental reporting studies. There is also considerable interest for use of this model for other statewide planning purposes and by the regional agencies for understanding interregional travel.

The core model design feature that is unique from other statewide models is the recognition that interregional and urban area travel are distinct and should be modeled separately to capture these distinctions accurately. This leads to our approach to develop separate, but integrated, interregional and urban models, as demonstrated in Figure 2.1. There are two primary reasons for developing separate models for interregional and urban area travel: first, the trip purposes are different and second, the interregional travel models need to explicitly estimate induced demand. These models will be applied to both peak and off-peak conditions for an average weekday. Weekend travel demand and annual ridership estimates will be developed using annualization factors developed from observed data on high-speed rail systems around the world.

Figure 2.1 Integrated Modeling Process



There are three urban areas in the state that have more than one proposed high-speed rail station (San Francisco, Los Angeles, and San Diego) that warranted application of 4-step models. For these three areas, we will estimate travel demand for all transit and highway modes within the greater metropolitan areas separately from the interregional travel between urban areas. In addition, we have included additional zonal and network details for two urban areas (Sacramento and Bakersfield) to supplement the statewide information for these areas. This statewide model will predict interregional travel demand in the state of California and urban area travel demand within the three largest metropolitan regions. Travel within smaller metropolitan regions within the state (such as Fresno) is not included in the travel demand estimates because they are not eligible to use high-speed rail. Additional travel demand estimates will be conducted for the Tijuana external station based on data from the San Diego region to recognize the importance of the Tijuana Trolley. Other external stations will not be explicitly recognized, but estimates of visitors that currently use air travel within the state will be used to forecast potential high-speed rail ridership from visitors to the state.

2.2 Peer Review Comments

There were no significant comments from the peer review on the model design, since it was presented and discussed at the first peer review panel meeting. There was one question about how we would account for seasonal factors that may differ for air and high-speed rail travel. Seasonal and weekend travel factors will only be estimated for the high-speed rail system, so the air and conventional rail ridership estimates will be produced only for the average weekday.

In addition, our original model design did not include any information on visitors that might use the system. We propose instead to include estimates of visitors derived from available air demand data sources and then apply the same resident modal shares between air and high-speed rail to these non-residents. The panel agreed that it was better to include these estimates than to produce ridership for only residents.

3.0 Interregional Models

The focus of this peer review is on the development of the interregional models and the review of the forecasting assumptions (described in the next section). The validation of the integrated modeling approach and the application of the urban area models will be discusses, along with the initial forecasting model results, at the third and final peer review meeting.

3.1 Summary of Approach

There were three types of data compiled for the study: travel surveys, networks, and socioeconomic data. Some of the travel surveys were collected specifically for this study, three were available from MPOs around the state (SCAG, MTC, and SACOG), and there was a Caltrans statewide survey available. The new data collection included air and rail intercept surveys and household (primarily auto) surveys collected in 14 regions in California. After combining these surveys, 6,882 completed surveys were available to use for model estimation, as shown in Table 2.1. These surveys are summarized by the four trips purposes (business, commute, recreational and other) as well as the two distance classes (long and short trips) used throughout the modeling process. Distance classes were defined based on trips longer than 100 miles (long) and trips shorter than 100 miles (short) based on an analysis of the differences in trip characteristics.

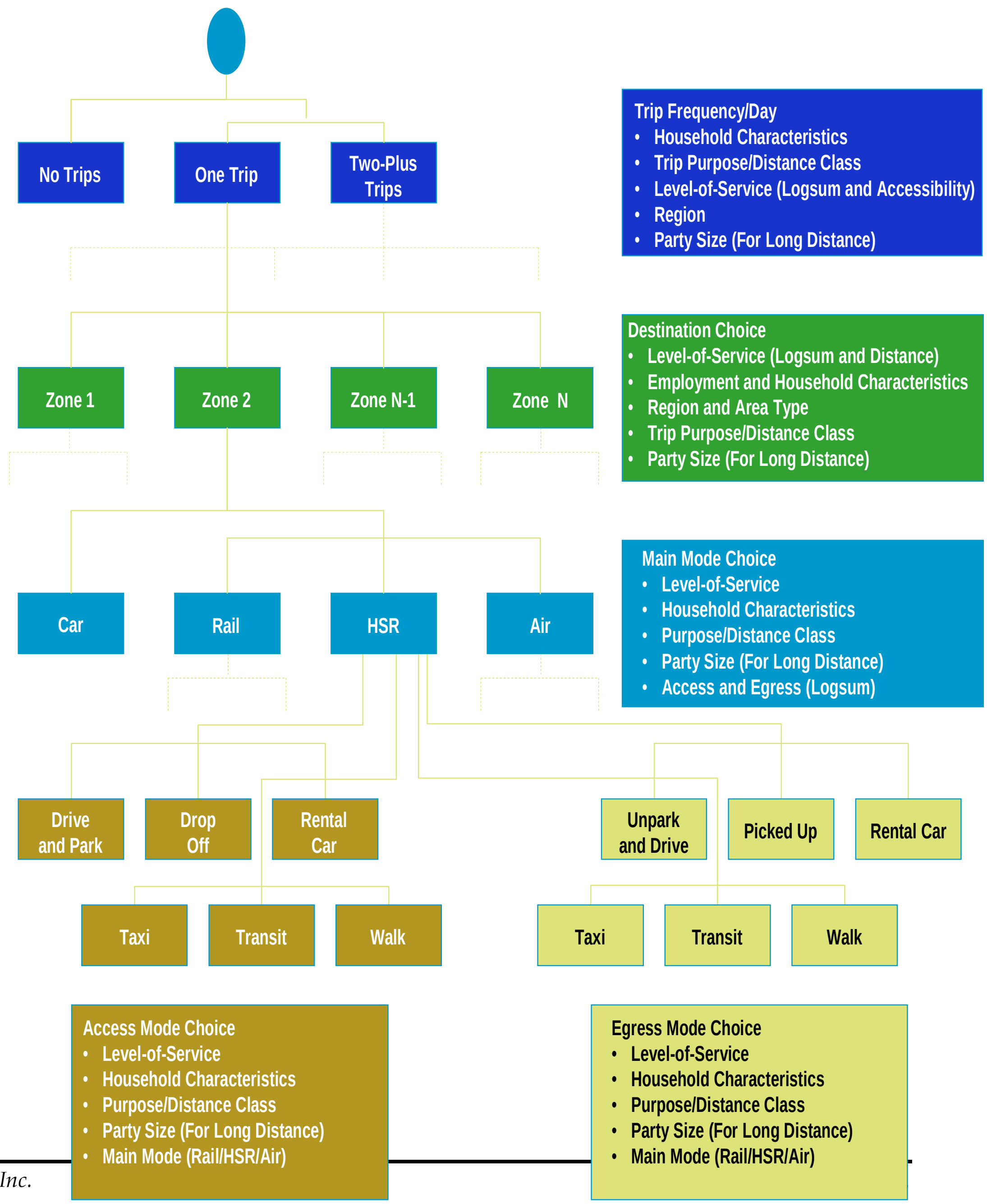
Table 3.1 Total of All Survey Interregional Trips by Mode, Distance, and Purpose

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	314	620	27	18	17	**996**
Commute	263	15	9	1	74	**362**
Recreation	1114	228	80	3	23	**1448**
Other	365	85	17	8	91	**566**
Short Trips						
Business	381	14	48	3	15	**461**
Commute	1136	0	168	9	108	**1421**
Recreation	873	2	29	3	52	**959**
Short Other	591	1	10	23	44	**669**
Total	**5,037**	**965**	**388**	**68**	**424**	**6,882**

There are highway, air, rail, and local transit networks to support both the urban area and interregional travel models. The socioeconomic data includes household data in 4 classifications (household size, income groups, number of workers, and vehicle ownership) and employment data by type.

The interregional models are comprised of four sets of models: trip frequency, destination choice, main mode choice, and access/egress mode choice. The structure and contents of the interregional modeling system is presented in Figure 3.1.

Figure 3.1 Interregional Model Structure



The trip frequency model component predicts the number of inter-regional trips that individuals in a household will make based on the household's characteristics and location. The destination choice model component predicts the destinations of the trips generated in the trip frequency component based on zonal characteristics and travel impedances. The mode choice components predict the modes that the travelers would choose based on the mode service levels and characteristics of the travelers and trips. The mode choice models include a main mode choice, where the primary inter-regional mode is selected, and access/egress components, where the modes of access and egress for the air and rail trips are selected.

The market segmentations used for the models are:

- Purpose:
  - Business (peak period);
  - Commute (peak period);
  - Recreation (off-peak period); and
  - Other (off-peak period).
- Distance range/residence area type:
  - Less than 100 miles, from large MPO regions;
  - Less than 100 miles, from small MPO regions; and
  - More than 100 miles.
- Household size – 1 person, 2 people, 3 people, more than 4 people.
- Household income range – Low, medium, or high.
- Household auto-ownership – 0, 1, 2+.
- Household number of workers – 1) no workers, 2) 1 worker, 3) 2+ workers.
- Party size: Traveling alone, traveling with others.

The distance ranges of less than or greater than 100 miles were determined by reviewing the trip length distributions from the surveys and judgment about behavior for short versus long trips. Party size is a segmentation variable primarily for the Recreation and Other segments, because it has a large effect on the travel cost of the car mode versus the other modes, and thus on the choices throughout the model chain. These market segments vary by model component to take advantage of additional detail in some areas or aggregation of market segments in other areas.

The details of the model components are contained in the interregional modeling system report. These include model specifications, descriptions of the model estimation data and model estimation results for each model component (trip frequency, party size, destination choice, access/egress mode choice and main mode choice models). The peer review comments include all relevant information from these models that the peer review committee discussed.

3.2 Peer Review Comments

The focus of the peer review comments on the interregional models were on the individual model components. There was one comment on the overall modeling system, which was that we need to consider seasonal factors to understand peak month, annual and weekend travel patterns. We will be reviewing existing high speed rail systems worldwide to develop annualization factors that can be used to convert average weekday ridership on high-speed rail to average annual ridership. We will not specifically estimate monthly or weekend travel patterns for this study and we will not estimate annual ridership for air, rail, or local transit systems.

Trip Frequency Models

In France, trip frequency is typically more related to train schedules and other mobility variables, so these models are often referred to as mobility models. These mobility models are often related to travel time. Since these models are more commonly referred to as trip frequency models in the U.S., we decided to retain the terminology for this project.

There was some confusion expressed about the naming of the individual market segments for the project to distinguish between the type of region as MPO and non-MPO or large MPO and small MPO. These market segments have been revised to be called large MPO regions and small MPO regions for clarity. The large MPO regions include SCAG, MTC, SANDAG, and SACOG. The small MPO regions include all other places in the state, even if they do not include an official MPO in the region.

The trip frequency models were initially estimated using accessibility measures as a weighted sum of the travel time to all potential destinations in the system. The weightings were based on population and employment in each traffic analysis zone. The travel times were peak or off-peak to support the business/commute or recreation/other trip purposes, respectively. This measure will be replaced by the actual logsum value from the destination choice models in the final estimation of the model. These accessibility measures were calculated separately for within each region and outside the region; the within region accessibility measures will be retained in the final models because the within region (or urban area) models are not destination choice models and are not able to produce logsums for this purpose.

Party Size Models

There were no significant comments from the peer review on the party size models. The results are generally intuitive and the panel agreed that it was a good idea to include party size in the mode choice models, thus establishing the need for party size models.

Destination Choice Models

The panel felt that the destination choice model results were sound and that the models incorporated the appropriate information. There were several comments on the presentation of the data in the report:

- The distribution of trips by trip length and purpose was shown in report and was confusing to the panel because it contains only data from the estimation dataset, which is not a truly random sample (because it was developed by merging several data sources). Thus, the distribution of trips by length and purpose show some trends in the data that are not likely to occur in a truly random survey, nor in the model application results. As a result, we have removed these graphs from the report. When we complete the validation, the distribution of trips by length and purpose can be charted and will be more informative.
- The table of the estimation data set by purpose, length, and source was provided only to show the sample sizes for model estimation of each destination choice model. Again, since these surveys do not represent a random sample, this table of distribution of trips by purpose and length may be misleading. The report has been updated to reflect that the sole purpose of this table is to show sample sizes for model estimation.
- The references to congested distances in the report should be revised to show that these are actually distances of trips along congested paths in the network for each origin-destination pair.

In addition, there were a few suggestions for modifications to the model specifications that should be considered during the final model estimation:

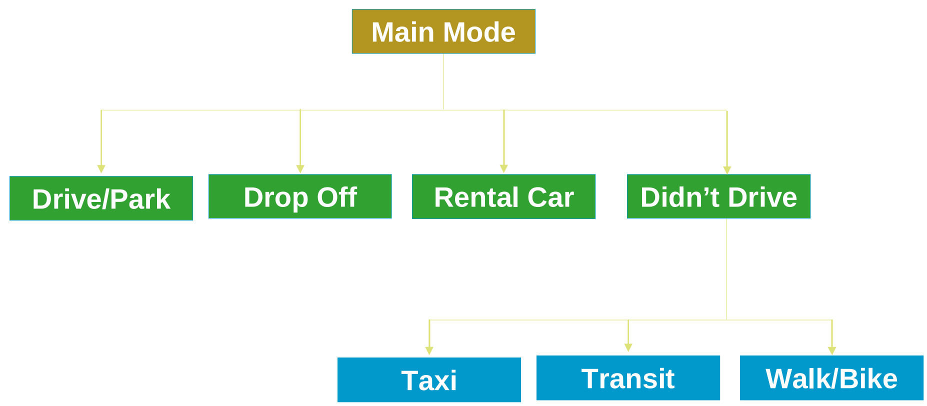
- There may be some issues with using the statewide model as the source for the mode choice model logsums for this initial model estimation. While this may be true, we do not believe they are systemic problems. Nonetheless, the panel suggested that we test the models with and without the distance variables when we re-estimate with the final logsums. We will be doing this as a test.
- Households were not considered as a size variable for the destination end of the trip in any of the destination choice models in the initial model estimation. Households can be attractors for recreation and other trips, in addition to employment. As a result, we recommended to the panel that this be considered in the final round of model estimation for recreation and other destination choice models and they agreed.

The final model estimation will also drop any insignificant variables that are not relevant to the modeling system. This process will be reflected in the final models reported in the final report on the interregional models.

Mode Choice Models

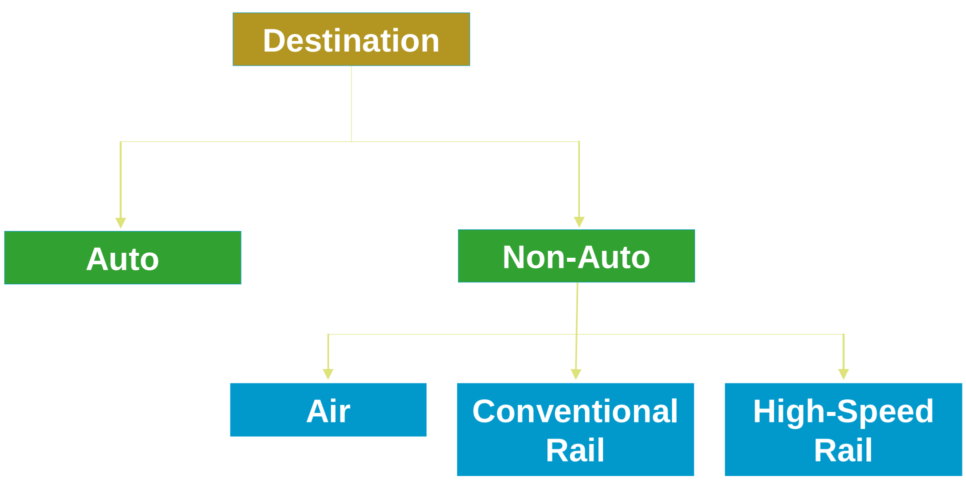
The panel felt that the two sets of mode choice model results were reasonable and that the models incorporated the appropriate information. There was a correction to the access/egress nested modeling structure to represent the "didn't drive" model in the upper nest and include bike modes with walk in a non-motorized mode; the corrected structure is presented in Figure 3.2.

Figure 3.2 Access/Egress Nested Model Structure



There was also a clarification for the main mode choice model nesting structure, where the upper nest was only between auto and non-auto modes. This is presented in Figure 3.3.

Figure 3.3 Main Mode Choice Nested Model Structure



There was discussion by the peer review about the impact of reservations and convenience on mode choice behavior, with mixed reviews from the panel. Having a reservation may shorten wait times, but having to make a reservation takes additional time before the trip starts. Reservations are required on the San Joaquin trains, but are not required on the Capitol Corridor trains. Regional high-speed services may or may not require reservations. Most of the panel felt that the reservation system did not significantly affect mode choice behavior and should therefore not be included in the models. In addition, there was no information on reservation systems collected in the stated preference survey, so there would be no statistical basis to include this variable in the models.

There was also discussion regarding the inclusion of a reliability measure in the mode choice models. The initial models indicate that reliability does not have a significant impact on modal choices, but this may be due to the definition of the reliability measure in the survey regarding on-time performance within 15 minutes of scheduled arrival (for auto, air and conventional rail) and within 5 minutes for high-speed rail. This measure, taken in the context of a longer interregional trip, is probably too narrow to adequately differentiate reliability among modes. In addition, the peer review panel felt that the measures needed to be consistent across modes. So the reliability measure was modified to reflect arrival within 60 minutes of scheduled (or expected) time. This will be modified in model calibration to the new measure. The specifications of the reliability measure are described more fully in the next section on level-of-service assumptions.

4.0 Forecasting Assumptions

4.1 Summary of Approach

Level-of-service (LOS) assumptions have been developed for the four interregional travel modes: auto, conventional rail, high-speed rail, and air. These assumptions cover three broad categories – costs, times and reliability, and taken together are called travel skims. Costs include auto operating costs, bridge tolls, and line-haul fares, as well as access and egress charges. Times include line-haul times, frequencies, access/egress time, terminal times, and transfer times. Reliability is a newly developed measure for the new statewide model system, defined by mode.

The future baseline networks were developed for each horizon year, including 2020, 2030 and 2050. For each of these years, assumptions about transportation infrastructure improvements must be made. The 2030 horizon year presents the best source of information, since this year is close to the horizon year for regional and metropolitan transportation plans (RTPs and MTPs, respectively). RTPs/MTPs for the four major urban areas have been identified and coded into the baseline transit and highway networks. For other areas of the State – particularly the Central Valley, the statewide travel model (STM) has been consulted. Assumptions about network improvements were identified by comparing the base and future networks.

There will be up to 72 alternatives developed and analyzed for the high-speed rail ridership and revenue study. These will be defined based on station locations, high-speed rail train service patterns, and specific project alternatives. These will also include a series of sensitivity tests to ensure that the model is producing reliable and consistent ridership forecasts.

Initial baseline high-speed rail system forecasts include 25 stations on the Pacheco Pass Alignment, and 26 stations on the Altamont Pass Alignment. Gilroy is included for the Pacheco Pass Alignment baseline alternative, while Tracy and Pleasanton are included in the Altamont Pass Alignment baseline alternative. The initial starting forecasts do not include service through to Oakland, though the Oakland-line stations will be analyzed in subsequent forecasts, as shown on Figure 4.1. Service through Merced, shown on Figure 4.1, is still an option. The current baseline service plan calls for one line in Southern California to extend to San Diego via the Inland Empire. The other line heads south along the I-405 corridor to Orange County with a terminus at Irvine. All trains stop at Los Angeles Union Station as presented in Figure 4.2.

Five lines are proposed for service, including:

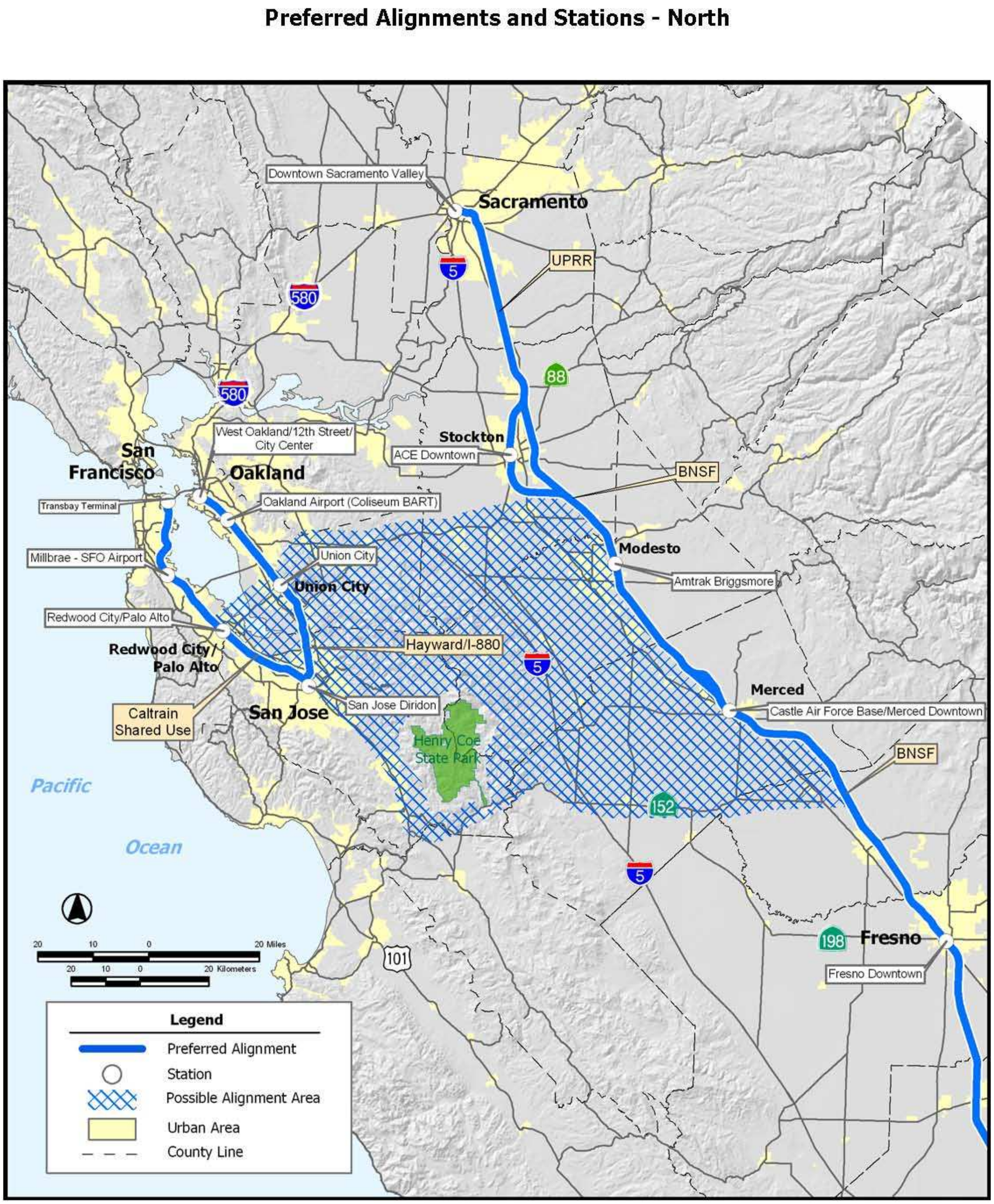
1. San Diego – Los Angeles – Sacramento;
2. Orange County – Los Angeles – Sacramento;

3. San Diego – Los Angeles – Bay Area;
4. Orange County – Los Angeles – Bay Area; and
5. Sacramento – Bay Area.

Station locations are divided by geographic area and line:

- Northern Central Valley: Sacramento, Stockton and Modesto;
- Bay Area: San Francisco, Millbrae, Palo Alto/Redwood City, San Jose, Oakland, Oakland Airport, and Union City.
  - Pacheco Pass Alignment: Gilroy/Morgan Hill
  - Altamont Pass Alignment: Pleasanton/Livermore, Tracy (San Joaquin County)
- Southern Central Valley: Merced, Fresno, Bakersfield, Visalia (optional);
- Los Angeles: Palmdale, Sylmar, Burbank, LAUS;
- Orange County Line: Norwalk (Los Angeles County), Anaheim, Irvine;
- Inland Empire: East San Gabriel Valley, Ontario, Riverside, Temecula; and
- San Diego: Escondido, University City, San Diego.

Figure 4.1 Proposed Northern California High-Speed Rail Stations and



Alignments

Figure4.2 Proposed Southern California High-Speed Rail Stations and Alignments

Preferred Alignments and Stations - South

Train service patterns describe the array of service options across each of the service lines. The CHSRA envisions five service options.

- Local stop trains stop at all stations from beginning to the end of the line. Local stop trains take fifty minutes longer to travel from Los Angeles to San Francisco (three hours twenty minutes, versus two hours thirty minutes).
- Express trains travel non-stop between LAUS and San Francisco or Sacramento. South of LAUS, trains either travel non-stop to San Diego, or travel all-stop (three stations) through Orange County. Some express trains may also stop at San Jose.
- Regional trains operate only from the Central Valley to either San Francisco or LAUS/San Diego. Most of the regional service is confined to the early hours to provide service that arrives in the large metro areas during the morning peak period.
- Semi-express trains stop at approximately one-third of the stations between San Francisco and Los Angeles. These trains tend to stop at San Jose, Fresno, and Bakersfield.
- Suburban trains make all stops in the Bay Area and in Southern California but bypass most or all of the Central Valley stations.

These service options will vary for each alternative.

4.2 Peer Review Comments

Cost Assumptions

We discussed the items included in the auto operating cost and whether it should include insurance to better represent federal reimbursement policies. The panel agreed that this was probably too high and we should retain the proposed auto operating costs developed by MTC. We also discussed whether to use the same cost inputs for urban and interregional models or vary them by region. The panel felt that auto operating cost was not significantly different by region and this was supported by the research completed by MTC on auto operating cost.

There was also debate among the panel about the high-speed rail fares, especially for short trips. Previous high-speed rail fares for longer trips were set at 50 percent of air fares and this assumption is proposed again. The panel felt that these fares were reasonable. The panel felt that the proposed fare of $5 for short high-speed rail trips was too low and that it should be at least 20 percent higher than fares for conventional rail in the same corridor. The revised proposed high-speed rail fare for shorter trips starts at $7.50 compared to similar conventional rail service ranging from $3 to $7 in most corridors.

Travel Times

Frequency and Wait Time

For all modes, service must first be assumed, and then we can apply the models to produce demand that is produced with that service. Service can be adjusted to better match demand after initial ridership is produced; this is typically referred to as an equilibration process. Since this study is focused on high-speed rail demand, we propose to assume air and conventional rail service will be set at 2005 service levels for future forecasts. The peer review panel concurred that we keep the frequencies for air and conventional rail supply constant over time and review the calculation of demand relative to supply.

Frequency is included in the mode choice models directly rather than the traditional wait times, calculated as half the headway, because frequency has a different impact on interregional travel than it does on urban travel. Wait times were estimated separately based direction from the peer review panel:

- An initial review of wait times for air travelers in the surveys collected for this project revealed no significant difference between wait times for business and non-business travelers. In addition, we believe that air traveler wait times are not a function of the air service frequencies, as recommended by the peer review panel. The rationale for using set wait times is each seat must be reserved in advance, so the presence of more or less frequent service between airport pairs does not influence the wait times. As a result, air wait times for air passengers will be set based on a review of the surveys reported wait times at 55 minutes. The air wait times are derived from self-reported data on arrival time before departure in the air passenger travel surveys collected for this study, which includes both wait and terminal times.
- For rail travel, the wait times are lower than air for a number of reasons. First, trains will have numerous doors, making boarding a train a much faster proposition than boarding an airplane. In addition, the hassle and time variance of getting a boarding pass, checking luggage, and getting through security requires arrival at the airport earlier than at a train station without security checkpoints. It is explicitly assumed that high-speed rail will not have the elaborate security check-in procedures, boarding passes will not be required to wait for a train, seats are not assigned, and that luggage is typically self-carried on the train. The peer review panel recommended that interregional rail travel wait times be in the range of 10 minutes to 20 minutes, with higher values for non-business travel. Since the air passenger surveys did not support separate wait times for business and non-business travelers, we propose to use a single wait time value for rail passengers as well. The rail wait time is set at 15 minutes for both high-speed and conventional rail travelers.

All of these factors combine to make train wait times much shorter than for air travel. During model calibration, we will separate terminal and wait times from the modal constant in the mode choice models so these can be included for policy testing.

Terminal Time

Terminal times are defined as the walk travel time between curbside and waiting areas. There was considerable discussion about the expected security measures that would be in place for each mode and how this would affect the terminal times. The panel felt that the proposed 5 minute terminal time for high-speed rail was too low. The following revised terminal times will be used:

- 12 minutes for downtown/terminal high-speed rail stations in San Diego, Irvine, Los Angeles, Sacramento, San Francisco, and Oakland. (These are the larger proposed high-speed rail stations, with more distant parking and longer walk times to local ground transportation);
- 8 minutes for other high-speed rail stations;
- 24 minutes for non-business/commute trips at Los Angeles and San Francisco Airports;
- 20 minutes for non-business/commute trips at other airports;
- 22 minutes for business/commute trips at Los Angeles and San Francisco Airports; and
- 18 minutes for business/commute trips at other airports.

These values average out to the 10 minute high-speed rail and 20 minute air terminal time recommendations of the peer group, but provide more differentiation that travelers generally encounter at larger airports and (presumably) high-speed rail stations.

Transfer Times

Transfer times were discussed by the peer review panel and proposed to be calculated as 50 percent of the headway for all modes, with a maximum of 15 minutes for relevant transfers. For interregional travel, transfer times are somewhat more complicated because local transit access/egress to/from the high-speed rail modes is part of the access/egress time. Because the interregional travel mode will be the primary mode of travel, it is assumed the traveler will know the schedule of the interregional mode, and will plan their trip accordingly. As a result, no time will be assessed for trips that include using local transit to access the interregional mode.

For example, consider a traveler living in San Francisco and traveling to Southern California. This traveler will take BART to San Francisco Airport, followed by a flight to a Southern California airport. The notion of assessing a transfer time of half the airline headway (or some similar such measure) does not make sense since the traveler will obviously take a BART train that gets him/her to the airport on time for their flight. In this case, all of the relevant access travel time components are applied – a walk to the BART station, a wait for the BART train to arrive, and the actual BART ride. From there, the traveler will walk from the BART platform to the San Francisco Airport entrance. The times, in total, comprise the access time. This traveler will have the airport terminal and wait times, as well as the airline flight time, for their trip, so an assessment of a transfer time for this trip would be redundant and unrealistic.

However, the egress mode for the return trip would assess the typical transfer time – for the airline to BART connection. In this case, the traveler will have flown back to San Francisco airport and will need to transfer to BART. Coming off a relatively long flight and egress terminal time, the traveler will likely to have to wait half the BART headway. The peer review panel suggested that the transfer egress time be capped at 15 minutes, and that recommendation has been implemented.

Reliability

As mentioned in the mode choice model discussion, there was agreement among the peer review panel that the reliability measure should be consistent among modes. In addition, there was agreement that a measure of on-time performance within 60 minutes of scheduled arrival was a reasonable measure for interregional travel. There was considerable discussion about the difference between minor delays and significant or catastrophic delays, which can cause service to be hours behind schedule. The panel felt that both should be incorporated if possible, based on available data.

The following measures of reliability by mode were developed based on the peer review panel's guidance:

- The auto measure of reliability that has been used on a series of studies by Cambridge Systematics is the freeway vehicle hours of delay. This measure indicates that as delay on the freeway increases, the overall reliability of the system would tend to decrease. The probability, expressed in decimal terms, of an auto traveler arriving within 60 minutes of the congested travel time can be found with the following function:

$$P = \left(\left(\frac{TC+60}{TC} \right) - \left[\frac{TC + \left(60 \times TO \times \left[0.0073 \times \frac{\left(\frac{TC}{TO} - 1 \right)^{1/8.5}}{0.18} \right]^{5.2695} \right)}{TC} \right] \right)$$

where:

TO = Freeflow travel time in minutes

TC = Congested travel time in minutes

The prior equation uses the concept of "travel time index", and essentially looks at the likelihood that someone's trip will be delayed by 60 minutes or more by non-recurring incident delay. The probability is referenced against congested travel time, since auto travelers presumably already account for the effects of recurring congestion in their mode choice decisions. The portion of the equation shown in bold represents the estimate of incident delay, measured in minutes.

There are a number of major simplifications and limitations with the preceding equation including, but not limited to, the following:

– The equation uses the freeway volume delay function for all origin-destination pairs. This function says that

– $TC = TO (1+0.18(Volume/Capacity)^{8.5}$.

– Travel distance is estimated using free-flow travel time and an assumed free-flow speed of 60 mph for all origin-destination pairs.

– The equation uses an incident delay function development for the FHWA IDAS software package for 6-lane freeways (3 lanes per direction). Linear regression was used to approximate a continuous function from the discrete look-up table in the IDAS User's Manual[1]. The IDAS "rates for off-peak or daily" reliability were used, with an additional assumption that the "1-hour level of service capacity" was equal to 1/14th of the link capacities in the high-speed rail model.

– The equation estimates incident delay uses average V/C ratio over the entire length of the trip. This is a limitation, as IDAS estimates incident delay from the V/C ratio on each individual link, but the equation has been scaled to account for this.

This auto reliability measure relies on existing research to define the function for determining auto reliability, but is applied on an origin-destination basis rather than a link basis for the purposes of this study. The resulting percent reliability estimates for a trip from Los Angeles to San Francisco are in the range of 67 percent to 92 percent, depending on the specific details of a trip. Trips with no congestion will have 100 percent reliability.

[1] Cambridge Systematics, IDAS User's Manual, prepared for the Federal Highway Administration.

- Airline reliability data for 2000 and 2005, as well as forecasts for 2025 were compiled from FAA data. Table 4.1 shows airport-to-airport reliability statistics for airports with the largest numbers of flights in 2000 and 2005. Airline travel shows reliability improvements since 2000, probably due to the airline practice of increasing scheduled air times to allow for better on-time performance.
- To gather conventional rail data, e-mails were sent to Henning Eichler (Metrolink), Brian Schmidt (ACE), and Steve Roberts (Amtrak). There was no available on-time performance data for rail services arriving within 60 minutes of the scheduled time. The proposed measurement takes into account the same relationship that air performance has between 5 and 60 minutes, and assesses individual performance for each service. The following reliability measures were obtained and estimated:
  - **ACE –** Reliability for ACE was measured within 5 minutes in the "Low 90s" through 1995. Since last year, ACE has had a number of reliability issues due to sharing track with freight rail. On-time performance within 60 minutes was estimated at 97 percent.
  - **Metrolink –** Metrolink reliability is tracked monthly route. Year 2000 reliability averaged 95 percent in 2000 and 94 percent in 2005. Metrolink reliability is measured as the percentage of trains arriving within 5 minutes of scheduled time. On-time performance within 60 minutes was estimated at 98 percent.
  - **San Joaquins –** The 5-year on-time performance within 5 minutes is 70 percent. On-time performance within 60 minutes was estimated at 89 percent.
  - **Capitol Corridor –** The 5-year on-time performance within 5 minutes is 82 percent. On-time performance within 60 minutes was estimated at 94 percent.
  - **Surfliners –** The 5-year on-time performance within 5 minutes is 83 percent. On-time performance within 60 minutes was estimated at 94 percent.

Table 4.1 Airline Reliability

ORIGIN	DEST	Percent More than 60 Minutes late (including canceled and diverted) 2000	2005	2025	Flights 2000	2005
Los Angeles	San Francisco	12.1%	6.1%	7.7%	16,021	8,427
San Francisco	Los Angeles	11.9%	5.0%	6.3%	15,967	8,503
Oakland	Los Angeles	9.2%	5.8%	7.4%	11,944	9,646
Los Angeles	Oakland	7.7%	4.7%	6.1%	11,861	9,665
Los Angeles	San Jose	7.9%	5.3%	6.3%	10,911	10,234
San Jose	Los Angeles	10.3%	4.2%	5.5%	10,861	10,237
San Diego	San Francisco	11.1%	5.0%	6.3%	7,320	3,332
San Francisco	San Diego	10.0%	4.2%	5.3%	7,288	3,090
San Jose	Santa Ana	6.3%	3.4%	4.2%	5,450	5,290
Santa Ana	San Jose	6.1%	4.0%	4.7%	5,435	5,457
San Jose	San Diego	7.7%	4.7%	5.8%	5,253	6,588
San Diego	San Jose	9.0%	4.2%	5.0%	5,231	6,603
Sacramento	Los Angeles	10.0%	5.0%	6.1%	5,229	5,608
Los Angeles	Sacramento	8.4%	5.5%	6.9%	5,181	5,627
Burbank	Oakland	6.1%	4.7%	5.8%	5,152	4,894
Oakland	Burbank	7.7%	5.5%	6.6%	5,124	4,906
Oakland	Ontario	5.5%	5.3%	6.6%	4,512	4,471
Burbank	San Francisco	10.8%	6.9%	8.4%	4,356	2,778
San Francisco	Burbank	10.6%	5.8%	7.4%	4,356	2,416
Ontario	Oakland	7.4%	5.0%	6.3%	4,151	4,468
Santa Ana	Oakland	5.5%	4.7%	5.8%	4,135	4,545
Oakland	Santa Ana	5.5%	4.5%	5.5%	4,133	4,538
San Diego	Sacramento	7.7%	5.8%	6.9%	3,852	4,853
San Diego	Oakland	6.9%	5.8%	7.1%	3,847	6,198
Sacramento	San Diego	7.1%	5.3%	6.1%	3,847	4,852
Santa Ana	San Francisco	10.3%	5.8%	7.1%	3,840	3,832
San Francisco	Santa Ana	7.9%	4.5%	5.5%	3,826	3,753
Oakland	San Diego	6.1%	5.0%	5.8%	3,795	6,208
Sacramento	Ontario	6.1%	4.5%	5.3%	3,713	4,087

Table 4.1 Airline Reliability (Continued)

		Percent More than 60 Minutes late (including canceled and diverted)			Flights	
ORIGIN	**DEST**	**2000**	**2005**	**2025**	**2000**	**2005**
Ontario	Sacramento	5.8%	4.7%	5.8%	3,686	4,072
Sacramento	Burbank	5.8%	4.5%	5.3%	3,410	3,404
Burbank	Sacramento	6.9%	4.7%	5.8%	3,389	3,406
Burbank	Santa Ana	6.3%	3.7%	4.5%	2,761	3,089
Santa Ana	Burbank	7.7%	4.5%	5.5%	2,760	3,070
Santa Ana	San Diego	8.2%	3.4%	4.5%	2,575	15,223
San Diego	Santa Ana	7.4%	3.2%	4.0%	2,573	15,237
Ontario	San Jose	7.4%	4.5%	5.5%	2,454	3,095
San Jose	Ontario	6.6%	4.5%	5.5%	2,452	3,070
Ontario	San Francisco	10.0%	7.1%	8.7%	2,163	215
San Francisco	Ontario	10.6%	5.0%	6.1%	2,161	215
San Francisco	Santa Barbara	9.2%	5.5%	6.6%	1,666	2,983
Santa Barbara	San Francisco	9.0%	6.3%	7.7%	1,620	2,869
Santa Ana	Sacramento	6.1%	5.3%	6.3%	1,560	2,461
Sacramento	Santa Ana	5.3%	4.2%	5.0%	1,560	2,459
Santa Barbara	Los Angeles	6.6%	2.6%	3.2%	981	5,911
San Francisco	Palm Springs	8.4%	8.4%	10.8%	936	965
Palm Springs	San Francisco	7.1%	6.3%	7.9%	935	947
Los Angeles	Santa Barbara	10.0%	2.6%	3.4%	932	5,692
Palm Springs	Los Angeles	7.1%	4.7%	5.8%	918	3,342
Los Angeles	Palm Springs	7.9%	4.0%	5.0%	918	3,321
San Francisco	Monterey	10.3%	5.5%	6.6%	341	2,633
Average		**8.6%**	**4.7%**	**5.8%**		

- Typical high-speed rail reliability for European and Japanese systems was analyzed by Systra staff. On dedicated high-speed rail track, even with express and local trains, both the French and Japanese have reported average delays of 29 to 40 seconds per train (including weather and earthquake delays), which basically is more than 99 percent on time (within 10 minutes of schedule in European practice). This is possible since the dispatching and signal/control environment are managed as a consistent centralized unit with very few opportunities for delay. The ensemble of TGV's have been running at around 90 percent on time, because they also operate on conventional lines with different types of equipment, grade crossings, and other opportunities for slow down. About one-half of the operating mileage is on conventional lines. In Japan, almost all the mileage is on dedicated right-of-way (ROW).

  In California, there will be origin-destination pairs that will have 100 percent dedicated rights-of-way (ROW), where a very high on-time performance (OTP) could be expected. This would include any origin-destination for San Diego-Los Angeles-Central Valley-Sacramento. Trains running into the Bay Area and Orange County would have more interaction with other operators, although there would be no grade crossings. An assumed 95 percent OTP on time performance within 5 minutes would represent a reasonable high-speed rail service assumption. Obviously, OTP depends a lot on the schedule pad that you put in, and the above assumes that the standard 5 percent pad in the times is included. This translates to 99 percent reliability for the defined criteria of on-time performance within 60 minutes.

Future Baseline

The BART to San Jose alternative will not be included in the future baseline network because it is not part of the adopted Regional Transportation Plan (RTP). SCAG projects listed in the proposed RTP were not financially constrained, so these were modified to include only the financially constrained projects, consistent with the other metropolitan areas. There was some discussion about the possibility of included financially unconstrained plans for testing, but the general consensus was that this was not necessary, given the level of effort involved.

There were a series of highway projects identified outside the four major metropolitan areas, but no significant transit projects. The background highway and transit networks do not contain projects included or under consideration as part of the statewide infrastructure bond initiative (November 2006). Forecasting analysis will have been well under way before the election is decided. In addition, there will be project-level competition for bond funds, so the project list is not complete.

Forecast Alternatives

The train service alternatives we have proposed offer several different train services for any particular origin-destination pair. These will be modeled based on the best path for a specific origin-destination pair, in each time period.

The project alternatives will include an initial run of the existing conditions with high-speed rail service in 2005 to compare to conventional rail ridership in this same time period. This will also enable us to evaluate the ridership impacts of high-speed rail for existing population and employment patterns rather than the growth expected in 2030. This alternative will be run for both the northern and southern alignments. This 2005 evaluation of high-speed rail ridership will also provide a better sense of opening year ridership than the longer-term 2030 forecasts.

At the current time, we have no plans to model the phasing plans for high-speed rail. The current project alternatives are focused on long-term (2030) ridership and revenue potential. There are also some longer-term forecast alternatives for 2040 and 2050 and shorter term forecasts for 2020.

Sensitivity tests will be performed for a series of various cost assumptions. The evaluation of different project alternatives will effectively test changes in travel time assumptions. We considered testing changes in socioeconomic data, based on the peer review panel suggestion, but this test would require extensive additional data processing and does not support the overall forecasting efforts for the CHSRA or MTC. Another suggestion by the peer review panel was to test changes in value of time. This test will be completed by the Regional Rail Study and is therefore not considered as a sensitivity study for this project. The panel suggested that we not test changes in electricity, since this is such a small portion of the total cost for high-speed rail operating cost.

5.0 Summary

5.1 Next Steps

The next steps in the high-speed rail study are to finalize the urban and interregional statewide models and conduct calibration and validation for the base year 2000. The finalization of the models involves producing logsums from mode choice to use in destination choice models and producing logsums from destination choice to use in trip frequency models. We will also test the performance of the model in year 2005 compared to a more limited set of validation data that are available. Then we will build the future baseline model and run several high-speed rail alternatives for the year 2030. This effort will also include several sensitivity tests to ensure that the model is producing reliable results.

After model calibration, validation, and initial forecasting activities are complete, we will present these data to the peer review panel in the 3rd and final report. Due to resource constraints, the 3rd peer review will be conducted by sending the peer review panel report and asking for written feedback. Conference calls will be set up to discuss any significant comments or considerations that are raised during this period. We will respond to any comments received on the model calibration, validation, or initial forecasts before the full production of high-speed rail alternatives is undertaken.

5.2 Action Items

There were a series of specific action items mentioned for consideration or inclusion into the modeling or forecasting approach. These are subdivided into the primary topics of interest below.

Model Development

There were a series of recommendations by the peer review panel that were agreed to during the meeting, as follows:

- We proposed consideration of estimating non-resident high-speed rail travel by separating current air demand into resident and non-resident segments and then assuming that non-resident mode shares for air and high-speed rail will mimic resident mode shares for air and high-speed rail. This approach serves to include non-resident demand for high-speed rail directly and assists in the calibration of air demand by including only resident air demand. We will review available data sources to estimate the resident/non-resident air demand shares to support this analysis.

- We will develop annualization factors from an evaluation of the high-speed rail systems in operation around the world. These annualization factors will allow us to predict annual ridership from our modeled estimates of average weekday ridership.
- There were a series of recommended changes to the model development report, which will be included into the final model development report along with the final models. These include changing the wording of the MPO and non-MPO market segments to large MPO and other regions market segments, showing distributions of data from model application rather than model estimation data, and revising mode choice model nests to reflect that the walk mode includes bike.
- We will finalize the trip frequency, destination, and mode choice models, which involves calculating the actual logsums from each lower level model and using these data to re-estimate the logsum variable in the upper level model (this will be done for trip frequency and destination choice). It also involves reviewing insignificant variables in each model to determine if we should drop them from the model specification or if they add value to the models (and are logical) indicating that we should retain them. There were a few ideas about new variables to test in these models, as follows:
  - Include households as a size variable in the destination choice models;
  - Revise the reliability model as a constrained variable to provide more intuitive results;
  - Test an interaction variable with cost and income in the main mode choice models; and
  - During model calibration for the main mode choice models, include the terminal and wait time variables to separate these factors from the modal bias constant.

There were also a series of recommendations by the peer review panel that were suggested for consideration. These are described below, along with the final actions determined by subsequent meetings between MTC, CHSRA, and consultant team staff:

- One peer review panel member requested that we consider replacing mode choice logsums in the urban distribution models to estimate the impacts of high-speed rail travel on urban trip lengths. This request was considered but will result in a high level of effort and is not expected to result in any significant differences in high-speed rail ridership, so we will not be pursuing this recommendation. This option can be pursued by MPOs wishing to evaluate this impact on their own urban models for those purposes (such as work) that are currently already incorporating mode choice logsums.
- One peer review panel member asked us to consider changing the name of the trip frequency models to mobility models to indicate the relationship of

these models to travel demand. This was discussed further but we concluded that trip frequency was a common term understood by model developers in the U.S. and we should retain this terminology.

- There was a substantive discussion about the need to include some measure of a reservation system or the convenience/inconvenience of having to make reservations ahead of time or at the station. There were some responses that this type of information would not significantly influence travel behavior and therefore would not warrant inclusion in the models. In addition, these data were not collected in our surveys, so it would not be possible to include in the estimated models.

Forecast Assumptions

There were a series of recommendations by the peer review panel that were agreed to during the meeting, as follows:

- One suggestion from the peer review panel was to increase the auto operating cost to include insurance and other items consistent with the federal reimbursement policies. After discussing this with the panel, we agreed that this would create auto operating costs that were too high and that the research MTC had done in creating the auto operating cost assumptions was sound and should be retained as is.
- Another consideration from the peer review panel was to vary the cost inputs for auto operating cost by region. After reviewing the northern and southern California gas prices, we concluded that this difference was not significant to warrant including separate auto operating costs by region.
- The high-speed rail fares were reviewed and revised according to a series of suggested relationships to air and conventional rail fares. These fares were also reviewed in the context of the previous CHSRA fares used in prior ridership evaluations and set according to the same assumptions. These high-speed rail fares will be a starting point for ridership evaluations and may be adjusted following the sensitivity analyses.
- The wait, terminal, and transfer time assumptions for rail and air modes were reconsidered following extension discussion from the peer review panel. In addition, we will test including the wait and terminal times by mode in the mode choice model during calibration as separate variables, so that changes in these policy variables can be tested.
- While the peer review panel felt that the inclusion of reliability measures was an important component of the models, there was much discussion on the specifics. The reliability measure was refined to provide consistency across modes and will be included with a more significant coefficient in the mode choice model, established during the model calibration phase.
- Financially constrained and unconstrained plans for inclusion into the future baseline were discussed statewide. There was consensus that financially

constrained plans should be used, that the unconstrained plans were not necessary to incorporate, and that all the projects identified were from financially unconstrained plans except for SCAG. The SCAG financially constrained plans were obtained and incorporated into the report. Some testing of the financially unconstrained plans in northern California will be tested as part of the Regional Rail Study.

- Sensitivity tests were proposed and discussed by the panel. Two other tests were suggested (socioeconomic data and value of time) but were not considered to be necessary by the panel. One test for more or less expensive electricity was eliminated because it is not a significant portion of the operating cost for high-speed rail.